Cruise Report

U.S. Geological Survey Cruise Report 2016-674-FA

September 14 – September 19, 2016

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USGS

Summary

During September 14 – September 19, 2016, the Pacific Coastal and Marine Science Center of the U.S. Geological Survey (USGS) conducted a survey collecting bathymetry data offshore of the Santa Cruz County shoreline, from Point Santa Cruz to the Moss Landing Harbor jetty. The work was conducted using personal water craft (PWC) and an outboard motor boat out of the Santa Cruz and Moss Landing harbors. This survey is part of a series designed to document changes in shoreline position and coastal morphology in northern Monterey Bay related to episodic, seasonal and interannual processes.

The majority of the California coastline is actively eroding and major storms (El Niño) have caused significant shoreline retreat and property damage. During the next 100 years sea level is projected to rise ~1 m in California (NRC, 2012), making it increasingly important to understand the complex sediment transport and sedimentation patterns that control beach mophodynamics. The West Coast of the United States is among the least understood of the coastal environments, because high wave energy has limited the use of traditional monitoring methods used to study processes controlling sediment transport. The Santa Cruz Littoral Cell has a wide range of coastal morphologic settings, wave exposure, river influences, levels of coastal development and flooding vulnerabilities, making it an excellent opportunity to understand how different sites respond on storm and interannual time scales. This research project has received authorization through the Monterey Bay National Marine Sanctuary under permit **MBNMS-2014-029-A1** and the California Department of Parks and Recreation.

The USGS research 2016-674-FA took place from September 14 – September 19, 2016. All operations took place during daylight hours between 08:10 AM and 2:01 PM Pacific Standard Time (PST). Bathymetric mapping was conducted using a PWC and an outboard motor boat, each equipped with a 200 kHz single beam echosounder and a GPS receiver. In accordance with the MBNMS permit, the vessels launched from either Santa Cruz or Moss Landing harbor and transited directly to the survey sites from Point Santa Cruz (Figure 1) to Moss Landing Harbor (Figure 2) and operated at speeds at, or less than, 4 knots once at the survey site. Fueling occurred prior to launching the vessels and did not land on the shoreline. Prior to operation, the U.S. Coast Guard and two MBNMS points of contact were notified of the plan and purpose for the survey. Figures 1 & 2 show the location of the survey track lines, with track line time and starting and ending locations listed in Table 1. Weather observations are provided in Appendix A and marine wildlife observations are provided in Appendix B. Exhibit H is provided in Appendix C.

References

National Research Council, 2012. Sea-Level Rise for the Coastal of California, Oregon, and Washington: Past, Present, and Future. Washington, DC: The National Academies Press.

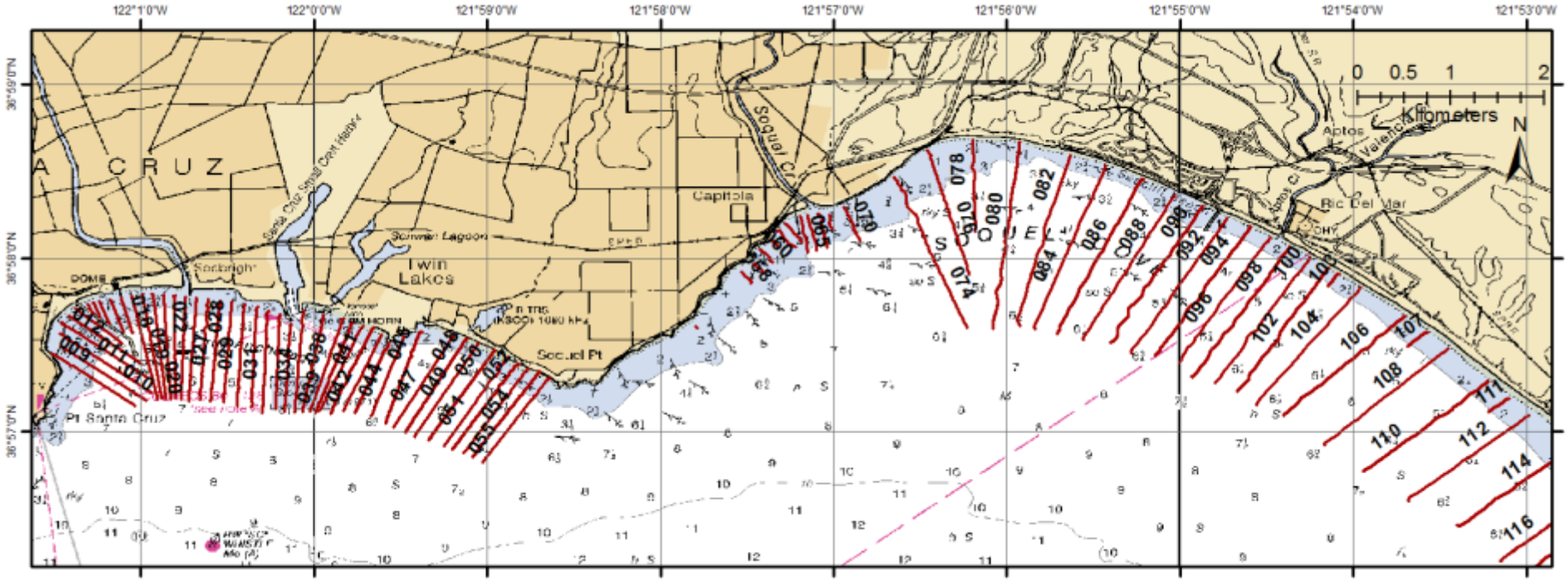

Figure 1. Northern extent of bathymetric data locations collected from September 14 – September 19, 2016 offshore of Santa Cruz County. Map projection is UTM Zone 10, meters.

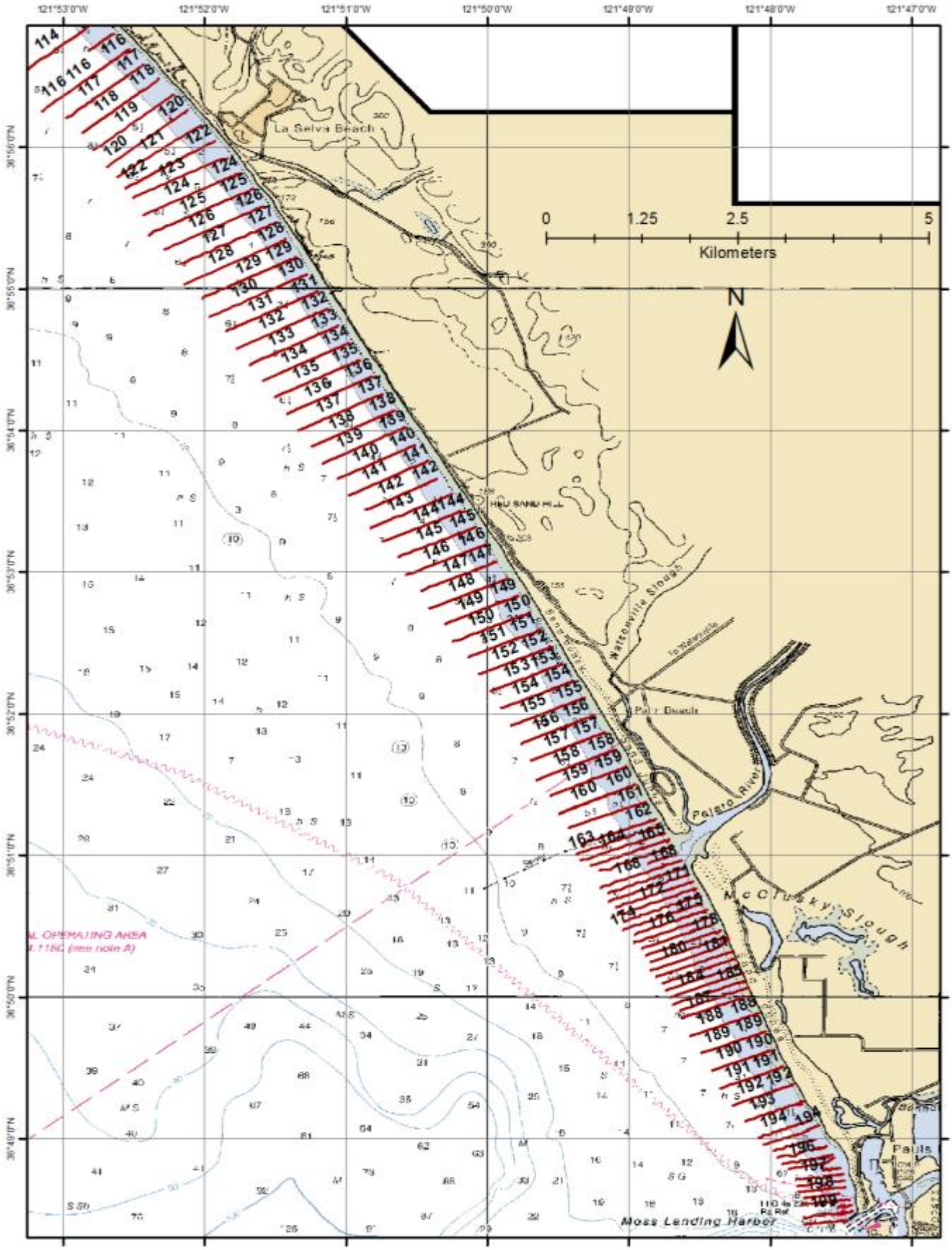

Figure 2. Southern extent of bathymetric data locations collected from September 14 – September 19, 2016 offshore of Santa Cruz County. Map projection is UTM Zone 10, meters.

Table 1. Survey track information.

Line #	Date	Start Time (PST)	End Time (PST)	Start Latitude	Start Longitude	End Latitude	End Longitude
200	9/14/2016	9:58 AM	10:00 AM	36.806658	-121.795433	36.807011	-121.791123
199	9/14/2016	10:02 AM	10:05 AM	36.807998	-121.791089	36.807443	-121.796124
200	9/14/2016	10:09 AM	10:09 AM	36.806585	-121.795926	36.806773	-121.79523
198	9/14/2016	10:12 AM	10:14 AM	36.809705	-121.796112	36.810235	-121.791929
197	9/14/2016	10:16 AM	10:18 AM	36.812376	-121.792972	36.811903	-121.796959
196	9/14/2016	10:19 AM	10:22 AM	36.813731	-121.798564	36.814587	-121.793682
195	9/14/2016	10:23 AM	10:26 AM	36.816575	-121.794841	36.815254	-121.799603
194	9/14/2016	10:28 AM	10:30 AM	36.816798	-121.801402	36.818222	-121.797084
193	9/14/2016	10:32 AM	10:34 AM	36.820402	-121.797955	36.818689	-121.802953
192	9/14/2016	10:36 AM	10:39 AM	36.820554	-121.804446	36.822369	-121.799502
191	9/14/2016	10:40 AM	10:43 AM	36.82429	-121.80081	36.822615	-121.805923
190	9/14/2016	10:44 AM	10:47 AM	36.824697	-121.80689	36.826423	-121.801955
189	9/14/2016	10:48 AM	10:50 AM	36.828288	-121.803512	36.826765	-121.80819
188	9/14/2016	10:57 AM	11:00 AM	36.828766	-121.809463	36.830597	-121.803937
187	9/14/2016	11:01 AM	11:04 AM	36.832589	-121.805231	36.830868	-121.810452
186	9/14/2016	11:05 AM	11:07 AM	36.831755	-121.810638	36.83359	-121.805309
185	9/14/2016	11:08 AM	11:11 AM	36.834317	-121.805871	36.832477	-121.811471
184	9/14/2016	11:12 AM	11:15 AM	36.833282	-121.811927	36.835295	-121.806009
183	9/14/2016	11:15 AM	11:18 AM	36.836006	-121.806574	36.834104	-121.812392
182	9/14/2016	11:19 AM	11:22 AM	36.834935	-121.812712	36.836923	-121.806994
181	9/14/2016	11:23 AM	11:26 AM	36.837631	-121.807585	36.835763	-121.81343
180	9/14/2016	11:27 AM	11:30 AM	36.836501	-121.814116	36.838705	-121.807711
179	9/14/2016	11:30 AM	11:33 AM	36.8393	-121.808366	36.837479	-121.814155
178	9/14/2016	11:34 AM	11:37 AM	36.838229	-121.814688	36.840374	-121.808403
177	9/14/2016	11:38 AM	11:41 AM	36.841129	-121.808916	36.839066	-121.815123
176	9/14/2016	11:41 AM	11:45 AM	36.839751	-121.816094	36.842203	-121.808678
175	9/14/2016	11:46 AM	11:49 AM	36.843072	-121.808993	36.840673	-121.816011
174	9/14/2016	11:50 AM	11:53 AM	36.841236	-121.817321	36.843721	-121.810067
173	9/14/2016	11:54 AM	11:58 AM	36.844543	-121.810304	36.842226	-121.817281
172	9/14/2016	12:10 PM	12:13 PM	36.842979	-121.818043	36.845317	-121.811064
171	9/14/2016	12:13 PM	12:17 PM	36.846051	-121.811521	36.843915	-121.818176
170	9/14/2016	12:18 PM	12:21 PM	36.844574	-121.819067	36.846783	-121.812465
169	9/14/2016	12:21 PM	12:24 PM	36.847693	-121.812616	36.845551	-121.819144
168	9/14/2016	12:25 PM	12:29 PM	36.846243	-121.820106	36.849024	-121.812725
166	9/14/2016	12:39 PM	12:42 PM	36.850266	-121.813719	36.848233	-121.820186
165	9/14/2016	12:43 PM	12:46 PM	36.848847	-121.821147	36.850975	-121.814659
164	9/14/2016	12:47 PM	12:50 PM	36.851731	-121.815173	36.849467	-121.822402
163	9/14/2016	12:51 PM	12:54 PM	36.850167	-121.822808	36.852488	-121.816017
162	9/14/2016	12:55 PM	12:58 PM	36.85333	-121.816203	36.851225	-121.822244
161	9/14/2016	12:59 PM	1:02 PM	36.853282	-121.82375	36.85534	-121.817654
160	9/14/2016	1:03 PM	1:06 PM	36.857224	-121.818892	36.85502	-121.824694
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198_1	9/14/2016	1:42 PM	1:43 PM	36.80942	-121.792268	36.808973	-121.796182
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131	9/15/2016	11:56 AM	11:57 AM	36.915464	-121.85554	36.916434	-121.853446
130	9/15/2016	11:58 AM	11:59 AM	36.917179	-121.857216	36.918374	-121.854571
129	9/15/2016	12:00 PM	12:03 PM	36.919158	-121.858698	36.920409	-121.855975
126	9/15/2016	12:01 PM	12:06 PM	36.92128	-121.871466	36.92562	-121.861465
128	9/15/2016	12:03 PM	12:06 PM	36.921425	-121.859219	36.922557	-121.857135
127	9/15/2016	12:07 PM	12:08 PM	36.923367	-121.860653	36.92449	-121.858307
125	9/15/2016	12:08 PM	12:14 PM	36.927358	-121.863328	36.92297	-121.873296
126	9/15/2016	12:09 PM	12:11 PM	36.925423	-121.862186	36.926388	-121.859717
125	9/15/2016	12:12 PM	12:14 PM	36.927105	-121.864114	36.928422	-121.860948
124	9/15/2016	12:15 PM	12:20 PM	36.925315	-121.873962	36.929316	-121.864772
124	9/15/2016	12:15 PM	12:17 PM	36.92921	-121.865174	36.930278	-121.862437
122	9/15/2016	12:23 PM	12:28 PM	36.932846	-121.867754	36.928428	-121.876009
123	9/15/2016	12:23 PM	12:28 PM	36.927337	-121.875045	36.932044	-121.863947
120	9/15/2016	12:30 PM	12:34 PM	36.930986	-121.878217	36.936336	-121.870647
122	9/15/2016	12:30 PM	12:32 PM	36.932767	-121.868058	36.934059	-121.865483
120	9/15/2016	12:34 PM	12:35 PM	36.93634	-121.870642	36.936765	-121.870807
121	9/15/2016	12:35 PM	12:40 PM	36.929777	-121.877	36.935942	-121.867156
118	9/15/2016	12:37 PM	12:42 PM	36.9401	-121.873764	36.934996	-121.881048
120	9/15/2016	12:41 PM	12:42 PM	36.936121	-121.870985	36.937672	-121.868676
116	9/15/2016	12:45 PM	12:49 PM	36.938007	-121.885275	36.94347	-121.877498
119	9/15/2016	12:46 PM	12:50 PM	36.932958	-121.879794	36.939515	-121.870315
117	9/15/2016	12:51 PM	12:56 PM	36.941814	-121.87562	36.936724	-121.883014
118	9/15/2016	12:51 PM	12:53 PM	36.939852	-121.874284	36.941368	-121.872207
117	9/15/2016	12:54 PM	12:55 PM	36.941597	-121.875806	36.9431	-121.873806
116	9/15/2016	12:57 PM	12:59 PM	36.943442	-121.877713	36.944855	-121.875557
116	9/16/2016	8:10 AM	8:15 AM	36.937583	-121.885819	36.944824	-121.875531
115	9/16/2016	8:16 AM	8:18 AM	36.94659	-121.877306	36.944669	-121.880271

114	9/16/2016	8:19 AM	8:24 AM	36.94821	-121.879252	36.940987	-121.890054
112	9/16/2016	8:25 AM	8:31 AM	36.943318	-121.894596	36.951573	-121.883013
111	9/16/2016	8:32 AM	8:33 AM	36.953189	-121.884903	36.951866	-121.886928
110	9/16/2016	8:34 AM	8:40 AM	36.954783	-121.886905	36.946224	-121.899014
108	9/16/2016	8:41 AM	8:47 AM	36.948718	-121.902649	36.958009	-121.890848
107	9/16/2016	8:48 AM	8:49 AM	36.959515	-121.892831	36.958198	-121.894723
106	9/16/2016	8:50 AM	8:55 AM	36.961055	-121.894966	36.951516	-121.906691
104	9/16/2016	8:57 AM	9:03 AM	36.952542	-121.909305	36.963898	-121.899247
103	9/16/2016	9:04 AM	9:05 AM	36.965132	-121.901309	36.963967	-121.902366
102	9/16/2016	9:06 AM	9:11 AM	36.965681	-121.902302	36.953848	-121.911144
100	9/16/2016	9:12 AM	9:18 AM	36.954628	-121.913266	36.966763	-121.90412
098	9/16/2016	9:19 AM	9:26 AM	36.967749	-121.905972	36.955279	-121.915574
096	9/16/2016	9:28 AM	9:34 AM	36.956583	-121.916699	36.968736	-121.907916
094	9/16/2016	9:35 AM	9:41 AM	36.969656	-121.90983	36.957226	-121.919064
092	9/16/2016	9:41 AM	9:48 AM	36.957576	-121.921284	36.970569	-121.912106
090	9/16/2016	9:50 AM	9:56 AM	36.971644	-121.914371	36.958525	-121.923388
088	9/16/2016	9:57 AM	10:04 AM	36.958852	-121.925893	36.97282	-121.917132
086	9/16/2016	10:05 AM	10:13 AM	36.974215	-121.920156	36.959412	-121.928478
084	9/16/2016	10:14 AM	10:21 AM	36.959862	-121.930539	36.975593	-121.923813
082	9/16/2016	10:29 AM	10:36 AM	36.960156	-121.932038	36.976594	-121.927237
080	9/16/2016	10:37 AM	10:46 AM	36.977775	-121.932042	36.959869	-121.934606
078	9/16/2016	10:58 AM	11:02 AM	36.969252	-121.936344	36.978069	-121.936612
076	9/16/2016	11:05 AM	11:12 AM	36.977071	-121.940925	36.965117	-121.936934
074	9/16/2016	11:14 AM	11:24 AM	36.959948	-121.937149	36.974474	-121.944194
070	9/16/2016	11:28 AM	11:31 AM	36.9716	-121.949021	36.9683	-121.947469
068	9/16/2016	11:38 AM	11:40 AM	36.969422	-121.950172	36.970885	-121.950415
067	9/16/2016	11:41 AM	11:44 AM	36.970915	-121.951409	36.967699	-121.950643
066	9/16/2016	11:45 AM	11:47 AM	36.967394	-121.951645	36.970836	-121.952527
065	9/16/2016	11:48 AM	11:50 AM	36.970726	-121.953255	36.967216	-121.952465
063	9/16/2016	11:56 AM	11:58 AM	36.968293	-121.953039	36.970035	-121.954717
062	9/16/2016	11:58 AM	12:00 PM	36.969276	-121.955455	36.967747	-121.953631
061	9/16/2016	12:02 PM	12:03 PM	36.967744	-121.955169	36.968245	-121.955775
060	9/16/2016	12:04 PM	12:06 PM	36.967472	-121.956938	36.966268	-121.955809
059	9/16/2016	12:07 PM	12:08 PM	36.96532	-121.956797	36.966176	-121.957743
058	9/16/2016	12:10 PM	12:11 PM	36.964254	-121.957974	36.965375	-121.958904
057	9/16/2016	12:19 PM	12:19 PM	36.960141	-121.963259	36.959923	-121.963101
009	9/19/2016	9:31 AM	9:36 AM	36.952455	-122.017299	36.957526	-122.0253
010	9/19/2016	9:37 AM	9:43 AM	36.958128	-122.024459	36.952962	-122.016155
011	9/19/2016	9:43 AM	9:49 AM	36.9537	-122.015662	36.959442	-122.024574
012	9/19/2016	9:49 AM	9:55 AM	36.960341	-122.024319	36.955242	-122.016137
013	9/19/2016	9:56 AM	10:00 AM	36.956503	-122.016655	36.961131	-122.023624
014	9/19/2016	10:00 AM	10:03 AM	36.961718	-122.022949	36.958432	-122.018547
015	9/19/2016	10:07 AM	10:08 AM	36.961343	-122.021185	36.962239	-122.021886
15_1	9/19/2016	10:08 AM	10:10 AM	36.962381	-122.021349	36.960997	-122.020634
016	9/19/2016	10:10 AM	10:12 AM	36.960306	-122.019731	36.962596	-122.020744
017	9/19/2016	10:13 AM	10:15 AM	36.962636	-122.019689	36.959614	-122.018408
018	9/19/2016	10:15 AM	10:18 AM	36.959485	-122.017561	36.962909	-122.018586
019	9/19/2016	10:18 AM	10:25 AM	36.96306	-122.017662	36.953085	-122.015125

020	9/19/2016	10:25 AM	10:31 AM	36.953148	-122.014662	36.963231	-122.016508
021	9/19/2016	10:32 AM	10:38 AM	36.963168	-122.01572	36.953156	-122.014291
022	9/19/2016	10:38 AM	10:44 AM	36.953075	-122.013828	36.963176	-122.014522
023	9/19/2016	10:45 AM	10:45 AM	36.963087	-122.013438	36.963089	-122.013432
023	9/19/2016	10:45 AM	10:51 AM	36.963092	-122.013426	36.953148	-122.013406
024	9/19/2016	10:52 AM	10:58 AM	36.95307	-122.012801	36.962913	-122.01241
025	9/19/2016	10:58 AM	11:05 AM	36.962836	-122.011479	36.952928	-122.01213
026	9/19/2016	11:08 AM	11:15 AM	36.953045	-122.011075	36.962733	-122.010209
027	9/19/2016	11:15 AM	11:20 AM	36.96256	-122.00908	36.952848	-122.010022
028	9/19/2016	11:20 AM	11:25 AM	36.952831	-122.008706	36.962467	-122.007915
029	9/19/2016	11:26 AM	11:31 AM	36.962272	-122.006702	36.952429	-122.007428
030	9/19/2016	11:31 AM	11:36 AM	36.952288	-122.006118	36.961996	-122.005432
031	9/19/2016	11:37 AM	11:37 AM	36.961676	-122.004424	36.961672	-122.004416
031	9/19/2016	11:37 AM	11:42 AM	36.961671	-122.004414	36.951745	-122.005045
032	9/19/2016	11:42 AM	11:47 AM	36.952153	-122.003705	36.961242	-122.003322
033	9/19/2016	11:48 AM	11:53 AM	36.960337	-122.002312	36.95187	-122.002859
034	9/19/2016	11:53 AM	11:58 AM	36.951902	-122.001921	36.961637	-122.001047
036	9/19/2016	11:59 AM	12:04 PM	36.961222	-121.999189	36.951893	-122.001166
038	9/19/2016	12:04 PM	12:09 PM	36.951945	-122.000436	36.960919	-121.99714
039	9/19/2016	12:13 PM	12:17 PM	36.960484	-121.996363	36.951767	-121.999909
040	9/19/2016	12:18 PM	12:22 PM	36.951926	-121.999532	36.960155	-121.995276
041	9/19/2016	12:23 PM	12:28 PM	36.960034	-121.994327	36.951694	-121.998459
042	9/19/2016	12:29 PM	12:33 PM	36.951936	-121.997209	36.959272	-121.993525
043	9/19/2016	12:34 PM	12:38 PM	36.958521	-121.992883	36.951753	-121.996105
044	9/19/2016	12:38 PM	12:43 PM	36.951459	-121.994582	36.959182	-121.991357
045	9/19/2016	12:46 PM	12:53 PM	36.959537	-121.989628	36.950746	-121.993175
047	9/19/2016	12:56 PM	1:02 PM	36.95041	-121.992358	36.959385	-121.986502
048	9/19/2016	1:03 PM	1:09 PM	36.958979	-121.985285	36.949886	-121.991257
049	9/19/2016	1:10 PM	1:15 PM	36.949472	-121.990384	36.958497	-121.984167
050	9/19/2016	1:16 PM	1:22 PM	36.957891	-121.982761	36.949137	-121.989041
051	9/19/2016	1:23 PM	1:30 PM	36.948635	-121.987524	36.95714	-121.981351
052	9/19/2016	1:31 PM	1:39 PM	36.956484	-121.980347	36.948209	-121.986736
053	9/19/2016	1:41 PM	1:47 PM	36.947983	-121.985653	36.956048	-121.979337
054	9/19/2016	1:47 PM	1:54 PM	36.955767	-121.978255	36.947494	-121.984797
055	9/19/2016	1:55 PM	2:01 PM	36.947065	-121.983802	36.955173	-121.97733

Appendix A: Weather Observation Forms

Marine Environmental Variables Form

Dates: 3/21/2016 – 3/30/2016

Date	Time	Latitude	Longitude	Vessel Activity	Weather	Cloud Cover	Glare	Visibility	Wind Speed	Sea State	Swell Height	Monitors
9/14	10:46 am	36.807628	-121.794270°	Survey	None	None	Moderate	5+ nm	Light	Calm	1-1.5 m	SeanPaul La Selle / Jackson Currie
9/15	8:19 am	36.813770°	-121.798325°	Survey	None	None	Moderate	5+ nm	Light	Calm	0-1 m	SeanPaul La Selle / Jackson Currie
9/16	10:35 am	36.968851°	-121.910528°	Survey	None	None	Moderate	5+ nm	Light	Calm	1-1.5 m	Andy O'Neill / Jackson Currie
9/19	10:33 pm	36.955621°	-122.022110°	Survey	None	None	Moderate	5+ nm	Light	Calm	1-1.5 m	Andy O'Neill / Dan Hoover

Appendix B: Marine Wildlife Observations

Marine Wildlife Observations Form

Date: 9/14/2016 Monitor: SeanPaul La Selle / Jackson Currie

Time: 10:46 am	Latitude: 36.807628°	Longitude: -121.794270°
Weather: Clear	Cloud Cover: None	Glare: None
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 2-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: 1 otter observed		
Time: 12:38 am	Latitude: 36.840073°	Longitude: -121.812671°
Weather: Clear	Cloud Cover: None	Glare: None
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 2-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: 1 Porpoise observed.		

Marine Wildlife Observations Form

Date: 9/15/2016 Monitor: SeanPaul La Selle / Jackson Currie

Time: 8:19 am	Latitude: 36.813770°	Longitude: -121.798325°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 1-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: 3 whales observed.		
Time: 8:20 am	Latitude: 36.813994°	Longitude: -121.797057°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 1-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: 1 sea lion observed.		
Time: 8:52 am	Latitude: 36.819117°	Longitude: -121.801899°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 1-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: 1 whale observed.		
Time: 10:30 am	Latitude: 36.846113°	Longitude: -121.817477°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 1-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: Whales observed.		
Time: 11:03 am	Latitude: 36.886766°	Longitude: -121.839702°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 1-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: 8 dolphins observed.		

Marine Wildlife Observations Form

Date: 9/16/2016 Monitor: Andy O'Neill / Jackson Currie

Time: 10:35 am	Latitude: 36.968851°	Longitude: -121.910528°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 2-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: Sea lion observed.		
Time: 10:41 am	Latitude: 36.967501°	Longitude: -121.914183°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 2-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: Group of sea lions observed near cement ship.		

Marine Wildlife Observations Form

Date: 9/19/2016 Monitor: Andy O'Neill / Dan Hoover

Time: 10:33 am	Latitude: 36.955621°	Longitude: -122.022110°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 2-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: Otters observed in kelp.		
Time: 10:57 am	Latitude: 36.958617°	Longitude: -122.019826°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 2-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: Sea lions swimming near wharf.		
Time: 11:30 am	Latitude: 36.960995°	Longitude: -122.009268°
Weather: Clear	Cloud Cover: None	Glare: Moderate
Visibility: 5+ nm	Wind Speed: Light	Sea State: calm
Swell Height: 2-3 feet	Survey Vessel Activity: Survey	
Marine Wildlife Observations and Interactions: 12+ otters observed.		

Appendix C: Exhibit H

Mitigation Measure (MM)	Location and Scope of Mitigation	Effectiveness Criteria	Monitoring or Reporting Action	Responsible Party	Timing	Implementation Date(s) and Initials
Air Quality and Greenhouse Gas (GHG) Emissions (MND Section 3.3.3)						
MM AIR-1: Engine Tuning, Engine Certification, and Fuels. The following measures will be required to be implemented by all Permittees under the Offshore Geophysical Permit Program (OGPP), as applicable depending on the county offshore which a survey is being conducted. Pursuant to section 93118.5 of CARB's Airborne Toxic Control Measures, the Tier 2 engine requirement applies only to diesel-fueled vessels.	All Counties: Maintain all construction equipment in proper tune according to manufacturers' specifications; fuel all off-road and portable diesel-powered equipment with California Air Resources Board (CARB)-certified motor vehicle diesel fuel limiting sulfur content to 15 parts per million or less (CARB Diesel).	Daily emissions of criteria pollutants during survey activities are minimized.	Determine engine certification of vessel engines. Review engine emissions data to assess compliance, determine if changes in tuning or fuel are required.	OGPP permit holder and contract vessel operator; California State Lands Commission (CSLC) review of Final Monitoring Report.	Prior to, during, and after survey activities. Submit Final Monitoring Report after completion of survey activities.	N/A
	Los Angeles and Orange Counties: Use vessel engines meeting CARB's Tier 2-certified engines or cleaner; the survey shall be operated such that daily NO_x emissions do not exceed 100 pounds based on engine certification emission factors. This can be accomplished with Tier 2 engines if daily fuel use is 585 gallons or less, and with Tier 3 engines if daily fuel use is 935 gallons or less.		Verify that Tier 2 or cleaner engines are being used. Calculate daily NO_x emissions to verify compliance with limitations.			
	San Luis Obispo County: Use vessel engines meeting CARB's Tier 2-certified engines or cleaner, accomplished with Tier 2 engines if daily fuel use is 585 gallons or less; all diesel equipment shall not idle for more than 5 minutes; engine use needed to maintain position in the water is not considered idling; diesel idling within 300 meters (1,000 feet) of sensitive receptors is not permitted; use alternatively fueled construction equipment on site where feasible, such as compressed natural gas, liquefied natural gas, propane or biodiesel.		Verify that Tier 2 or cleaner engines are being used. Inform vessel operator(s) of idling limitation. Investigate availability of alternative fuels.			
	Santa Barbara County: Use vessel engines meeting CARB's Tier 2-certified engines or cleaner, accomplished with Tier 2 engines if daily fuel use is 790 gallons or less.		Verify that Tier 2 or cleaner engines are being used. Investigate availability of alternative fuels.			
	Ventura County: Use alternatively fueled construction equipment on site where feasible, such as compressed natural gas, liquefied natural gas, propane or biodiesel.		Investigate availability of alternative fuels.			

Mitigation Measure (MM)	Location and Scope of Mitigation	Effectiveness Criteria	Monitoring or Reporting Action	Responsible Party	Timing	Implementation Date(s) and Initials
MM BIO-1: Marine Mammal and Sea Turtle Presence – Current Information.	All State waters; prior to commencement of survey operations, the geophysical operator shall: (1) contact the National Oceanic and Atmospheric Administration Long Beach office staff and local whale-watching operations and shall acquire information on the current composition and relative abundance of marine wildlife offshore, and (2) convey sightings data to the vessel operator and crew, survey party chief, and onboard Marine Wildlife Monitors (MWMs) prior to departure. This information will aid the MWMs by providing data on the approximate number and types of organisms that may be in the area.	No adverse effects to marine mammals or sea turtles due to survey activities are observed.	Document contact with appropriate sources. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder; Inquiry to NOAA and local whale watching operators.	Prior to survey.	8/19/16
MM BIO-2: Marine Wildlife Monitors (MWMs).	Except as provided in section 7(h) of the General Permit, a minimum of two (2) qualified MWMs who are experienced in marine wildlife observations shall be onboard the survey vessel throughout both transit and data collection activities. The specific monitoring, observation, and data collection responsibilities shall be identified in the Marine Wildlife Contingency Plan required as part of all Offshore Geophysical Permit Program permits. Qualifications of proposed MWMs shall be submitted to the National Oceanic and Atmospheric Administration (NOAA) and CSLC at least twenty-one (21) days in advance of the survey for their approval by the agencies. Survey operations shall not commence until the CSLC approves the MWMs.	Competent and professional monitoring or marine mammals and sea turtles; compliance with established monitoring policies.	Document contact with and approval by appropriate agencies. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Prior to survey.	8/19/16
MM BIO-3: Safety Zone Monitoring.	Onboard Marine Wildlife Monitors (MWMs) responsible for observations during vessel transit shall be responsible for monitoring during the survey equipment operations. All visual monitoring shall occur from the highest practical vantage point aboard the survey vessel; binoculars shall be used to observe the surrounding area, as appropriate. The MWMs will survey an area (i.e., safety or exclusion zone) based on the equipment used, centered on the sound source (i.e., vessel, towfish), throughout time that the survey equipment is operating. Safety zone radial distances, by equipment type, include:	No adverse effects to marine mammals or sea turtles due to survey activities are observed; compliance with established safety zones.	Compliance with permit requirements (observers); compliance with established safety zones. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Prior to survey.	8/19/16

Mitigation Measure (MM)	Location and Scope of Mitigation	Effectiveness Criteria	Monitoring or Reporting Action	Responsible Party	Timing	Implementation Date(s) and Initials
	<table><tr><th>Equipment Type</th><th>Safety Zone (radius, m)</th></tr><tr><td>Single Beam Echosounder</td><td>50</td></tr><tr><td>Multibeam Echosounder</td><td>500</td></tr><tr><td>Side-Scan Sonar</td><td>600</td></tr><tr><td>Subbottom Profiler</td><td>100</td></tr><tr><td>Boomer System</td><td>100</td></tr></table> If the geophysical survey equipment is operated at or above a frequency of 200 kilohertz (kHz), safety zone monitoring and enforcement is not required; however, if geophysical survey equipment operated at a frequency at or above 200 kHz is used simultaneously with geophysical survey equipment less than 200 kHz, then the safety zone for the equipment less than 200 kHz must be monitored. The onboard MWMs shall have authority to stop operations if a mammal or turtle is observed within the specified safety zone and may be negatively affected by survey activities. The MWMs shall also have authority to recommend continuation (or cessation) of operations during periods of limited visibility (i.e., fog, rain) based on the observed abundance of marine wildlife. Periodic reevaluation of weather conditions and reassessment of the continuation/cessation recommendation shall be completed by the onboard MWMs. During operations, if an animal's actions are observed to be irregular, the monitor shall have authority to recommend that equipment be shut down until the animal moves further away from the sound source. If irregular behavior is observed, the equipment shall be shut-off and will be restarted and ramped-up to full power, as applicable, or will not be started until the animal(s) is/are outside of the safety zone or have not been observed for 15 minutes. For nearshore survey operations utilizing vessels that lack the personnel capacity to hold two (2) MWMs aboard during survey operations, at least twenty-one (21) days prior to the commencement of survey activities, the Permittee may petition the CSLC to conduct survey operations with one (1) MWM aboard. The CSLC will consider such authorization on a case-by-case basis and					8/19/16

Mitigation Measure (MM)	Location and Scope of Mitigation	Effectiveness Criteria	Monitoring or Reporting Action	Responsible Party	Timing	Implementation Date(s) and Initials
	factors the CSLC will consider will include the timing, type, and location of the survey, the size of the vessel, and the availability of alternate vessels for conducting the proposed survey. CSLC authorizations under this subsection will be limited to individual surveys and under any such authorization; the Permittee shall update the MWCP to reflect how survey operations will occur under the authorization.					
MM BIO-4: Limits on Nighttime OGPP Surveys.	All State waters; nighttime survey operations are prohibited under the OGPP, except as provided below. The CSLC will consider the use of single beam echosounders and passive equipment types at night on a case-by-case basis, taking into consideration the equipment specifications, location, timing, and duration of survey activity.	No adverse effects to marine mammals or sea turtles due to survey activities are observed.	Presurvey request for nighttime operations, including equipment specifications and proposed use schedule. Document equipment use. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Approval required before survey is initiated. Monitoring Report following comple-tion of survey.	8/19/16
MM BIO-5: Soft Start.	All State waters; the survey operator shall use a "soft start" technique at the beginning of survey activities each day (or following a shut down) to allow any marine mammal that may be in the immediate area to leave before the sound sources reach full energy. Surveys shall not commence at nighttime or when the safety zone cannot be effectively monitored. Operators shall initiate each piece of equipment at the lowest practical sound level, increasing output in such a manner as to increase in steps not exceeding approximately 6 decibels (dB) per 5-minute period. During ramp-up, the Marine Wildlife Monitors (MWMs) shall monitor the safety zone. If marine mammals are sighted within or about to enter the safety zone, a power-down or shut down shall be implemented as though the equipment was operating at full power. Initiation of ramp-up procedures from shut down requires that the MWMs be able to visually observe the full safety zone.	No adverse effects to marine mammals or sea turtles due to survey activities are observed.	Compliance with permit requirements (observers); compliance with safe start procedures. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Imme-diately prior to survey.	9/14/16

Mitigation Measure (MM)	Location and Scope of Mitigation	Effectiveness Criteria	Monitoring or Reporting Action	Responsible Party	Timing	Implementation Date(s) and Initials
MM BIO-6: Practical Limitations on Equipment Use and Adherence to Equipment Manufacturer's Routine Maintenance Schedule.	All State waters; geophysical operators shall follow, to the maximum extent possible, the guidelines of Zykov (2013) as they pertain to the use of subbottom profilers and side-scan sonar, including: • Using the highest frequency band possible for the subbottom profiler; • Using the shortest possible pulse length; and • Lowering the pulse rate (pings per second) as much as feasible. Geophysical operators shall consider the potential applicability of these measures to other equipment types (e.g., boomer). Permit holders will conduct routine inspection and maintenance of acoustic-generating equipment to ensure that low energy geophysical equipment used during permitted survey activities remains in proper working order and within manufacturer's equipment specifications. Verification of the date and occurrence of such equipment inspection and maintenance shall be provided in the required presurvey notification to CSLC.	No adverse effects to marine mammals or sea turtles due to survey activities are observed.	Document initial and during survey equipment settings. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Imme-diately prior to and during survey.	9/14/16
MM BIO-7: Avoidance of Pinniped Haul-Out Sites.	The Marine Wildlife Contingency Plan (MWCP) developed and implemented for each survey shall include identification of haul-out sites within or immediately adjacent to the proposed survey area. For surveys within 300 meters (m) of a haul-out site, the MWCP shall further require that: • The survey vessel shall not approach within 91 m of a haul-out site, consistent with National Marine Fisheries Service (NMFS) guidelines; • Survey activity close to haul-out sites shall be conducted in an expedited manner to minimize the potential for disturbance of pinnipeds on land; and • Marine Wildlife Monitors shall monitor pinniped activity onshore as the vessel approaches, observing and reporting on the number of pinnipeds potentially disturbed (e.g., via head lifting, flushing into the water). The purpose of such reporting is to provide CSLC and California Department of Fish and Wildlife (CDFW) with information regarding potential disturbance associated with OGPP surveys.	No adverse effects to pinnipeds at haul outs are observed.	Document pinniped reactions to vessel presence and equipment use. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Monitoring Report following comple-tion of survey.	9/19/16

Mitigation Measure (MM)	Location and Scope of Mitigation	Effectiveness Criteria	Monitoring or Reporting Action	Responsible Party	Timing	Implementation Date(s) and Initials
MM BIO-8: Reporting Requirements – Collision.	All State waters; if a collision with marine mammal or reptile occurs, the vessel operator shall document the conditions under which the accident occurred, including the following: • Vessel location (latitude, longitude) when the collision occurred; • Date and time of collision; • Speed and heading of the vessel at the time of collision; • Observation conditions (e.g., wind speed and direction, swell height, visibility in miles or kilometers, and presence of rain or fog) at the time of collision; • Species of marine wildlife contacted (if known); • Whether an observer was monitoring marine wildlife at the time of collision; and, • Name of vessel, vessel owner/operator, and captain officer in charge of the vessel at time of collision. After a collision, the vessel shall stop, if safe to do so; however, the vessel is not obligated to stand by and may proceed after confirming that it will not further damage the animal by doing so. The vessel will then immediately communicate by radio or telephone all details to the vessel's base of operations, and shall immediately report the incident. Consistent with Marine Mammal Protection Act requirements, the vessel's base of operations or, if an onboard telephone is available, the vessel captain him/herself, will then immediately call the National Oceanic and Atmospheric Administration (NOAA) Stranding Coordinator to report the collision and follow any subsequent instructions. From the report, the Stranding Coordinator will coordinate subsequent action, including enlisting the aid of marine mammal rescue organizations, if appropriate. From the vessel's base of operations, a telephone call will be placed to the Stranding Coordinator, NOAA National Marine Fisheries Service (NMFS), Southwest Region, Long Beach, to obtain instructions. Although NOAA has primary responsibility for marine mammals in both State and Federal waters, the California Department of Fish and Wildlife (CDFW) will also be advised that an incident has occurred in State waters affecting a protected species.	No adverse effects to marine mammals or sea turtles due to survey activities are observed.	Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Monitoring Report following comple-tion of survey.	9/19/16

Mitigation Measure (MM)	Location and Scope of Mitigation	Effectiveness Criteria	Monitoring or Reporting Action	Responsible Party	Timing	Implementation Date(s) and Initials
MM BIO-9: Limitations on Survey Operations in Select Marine Protected Areas (MPAs).	All MPAs; prior to commencing survey activities, geophysical operators shall coordinate with the CLSC, California Department of Fish and Wildlife (CDFW), and any other appropriate permitting agency regarding proposed operations within MPAs. The scope and purpose of each survey proposed within a MPA shall be defined by the permit holder, and the applicability of the survey to the allowable MPA activities shall be delineated by the permit holder. If deemed necessary by CDFW, geophysical operators will pursue a scientific collecting permit, or other appropriate authorization, to secure approval to work within a MPA, and shall provide a copy of such authorization to the CSLC as part of the required presurvey notification to CSLC. CSLC, CDFW, and/or other permitting agencies may impose further restrictions on survey activities as conditions of approval.	No adverse effects to MPA resources due to survey activities are observed.	Monitor reactions of wildlife to survey operations; report on shutdown conditions and survey restart. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder; survey permitted by CDFW.	Prior to survey.	8/19/16
MM HAZ-1: Oil Spill Contingency Plan (OSCP) Required Information.	Permittees shall develop and submit to CSLC staff for review and approval an OSCP that addresses accidental releases of petroleum and/or non-petroleum products during survey operations. Permittees' OSCPs shall include the following information for each vessel to be involved with the survey: • Specific steps to be taken in the event of a spill, including notification names, phone numbers, and locations of: (1) nearby emergency medical facilities, and (2) wildlife rescue/response organizations (e.g., Oiled Wildlife Care Network); • Description of crew training and equipment testing procedures; and • Description, quantities, and location of spill response equipment onboard the vessel.	Reduction in the potential for an accidental spill. Proper and timely response and notification of responsible parties in the event of a spill.	Documentation of proper spill training. Notification of responsible parties in the event of a spill.	OGPP permit holder and contract vessel operator.	Prior to survey.	8/19/16
MM HAZ-2: Vessel fueling restrictions.	Vessel fueling shall only occur at an approved docking facility. No cross vessel fueling shall be allowed.	Reduction in the potential for an accidental spill.	Documentation of fueling activities.	Contract vessel operator.	Following survey.	9/19/16
MM HAZ-3: OSCP equipment and supplies.	Onboard spill response equipment and supplies shall be sufficient to contain and recover the worst-case scenario spill of petroleum products as outlined in the OSCP.	Proper and timely response in the event of a spill.	Notification to CSLC of onboard spill response equipment/supplies inventory, verify	Contract vessel operator.	Prior to survey.	8/19/16

Mitigation Measure (MM)	Location and Scope of Mitigation	Effectiveness Criteria	Monitoring or Reporting Action	Responsible Party	Timing	Implementation Date(s) and Initials
			ability to respond to worst-case spill.			
MM HAZ-1: Oil Spill Contingency Plan (OSCP) Required Information.	Outlined under **Hazards and Hazardous Materials** (above)					
MM HAZ-2: Vessel fueling restrictions.	Outlined under **Hazards and Hazardous Materials** (above)					
MM HAZ-3: OSCP equipment and supplies.	Outlined under **Hazards and Hazardous Materials** (above)					
MM BIO-9: Limitations on Survey Operations in Select MPAs.	Outlined under **Biological Resources** (above)					
MM REC-1: U.S. Coast Guard (USCG), Harbormaster, and Dive Shop Operator Notification.	All California waters where recreational diving may occur; as a survey permit condition, the CSLC shall require Permittees to provide the USCG with survey details, including information on vessel types, survey locations, times, contact information, and other details of activities that may pose a hazard to divers so that USCG can include the information in the Local Notice to Mariners, advising vessels to avoid potential hazards near survey areas. Furthermore, at least twenty-one (21) days in advance of in-water activities, Permittees shall: (1) post such notices in the harbormasters' offices of regional harbors; and (2) notify operators of dive shops in coastal locations adjacent to the proposed offshore survey operations.	No adverse effects to recreational divers from survey operations.	Notify the USCG, local harbormasters, and local dive shops of planned survey activity. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Prior to survey.	8/19/16

Mitigation Measure (MM)	Location and Scope of Mitigation	Effectiveness Criteria	Monitoring or Reporting Action	Responsible Party	Timing	Implementation Date(s) and Initials
MM FISH-1: U.S. Coast Guard (USCG) and Harbormaster Notification.	All California waters; as a survey permit condition, the CSLC shall require Permittees to provide the USCG with survey details, including information on vessel types, survey locations, times, contact information, and other details of activities that may pose a hazard to mariners and fishers so that USCG can include the information in the Local Notice to Mariners, advising vessels to avoid potential hazards near survey areas. Furthermore, at least twenty-one (21) days in advance of in-water activities, Permittees shall post such notices in the harbormasters' offices of regional harbors.	No adverse effects to commercial fishing gear in place.	Notify the USCG and local harbormasters of planned survey activity. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Prior to survey.	8/19/16
MM FISH-2: Minimize Interaction with Fishing Gear.	To minimize interaction with fishing gear that may be present within a survey area: (1) the geophysical vessel (or designated vessel) shall traverse the proposed survey corridor prior to commencing survey operations to note and record the presence, type, and location of deployed fishing gear (i.e., buoys); (2) no survey lines within 30 m (100 feet) of observed fishing gear shall be conducted. The survey crew shall not remove or relocate any fishing gear; removal or relocation shall only be accomplished by the owner of the gear upon notification by the survey operator of the potential conflict.	No adverse effects to commercial fishing gear in place.	Visually observe the survey area for commercial fishing gear. Notify the gear owner and request relocation of gear outside survey area. Submit Final Monitoring Report after completion of survey activities.	OGPP permit holder.	Imme-diately prior to survey (prior to each survey day).	9/14/16
MM FISH-1: USCG and Harbormaster Notification.	Outlined under **Commercial and Recreational Fisheries** (above)					

Acronyms/Abbreviations: CARB = California Air Resources Board; CDFW = California Department of Fish and Wildlife; CSLC = California State Lands Commission; dB = decibels; kHz = kilohertz; MPA = Marine Protected Area; MWCP = Marine Wildlife Contingency Plan; MWM = Marine Wildlife Monitor; m= meter(s); NOAA = National Oceanic and Atmospheric Administration; NO_x = Nitrogen Oxide; OGPP = Offshore Geophysical Permit Program; OSCP = Oil Spill Contingency Plan; USCG = U.S. Coast Guard